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IMPROVED MOTOR BEARING FOR SUBMERSIBLE MOTORS

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BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates in general to submersible pump motors, and in particular to a bearing assembly which resists rotation. The bearing assembly supports the shaft in the motor.

2. Description of the Prior Art

A submersible pump is a centrifugal pump having a submersible motor that rotates the shaft to drive the pump. The motors for high volume oil and water production may be from six to sixty feet in length and be rated at several hundred horsepower. Each motor has a stator secured within a tubular housing. The stator is made up of thin disks, called laminations, that are magnetic and insulated from each other by coatings. Windings extend through the laminations to the stator.

A rotor secured to a shaft rotates within the stator. Because of the long length, the rotor is made up of a number of rotor sections. Each rotor section comprises a large number of flat metal disks, called laminations, that are secured by copper rods. The disks are insulated from each other

1 by coatings. The rotor sections are spaced apart from each other, and a bearing assembly is located
2 between each rotor section to maintain the shaft in axial alignment. The rotor sections are keyed
3 to the shaft for rotation with the shaft, but are axially movable with respect to the shaft.

4 Each bearing assembly includes a sleeve keyed to the shaft for rotation. A bearing body fits
5 slidingly on the sleeve. An elastomeric ring encircles the bearing body, acting as a bearing member.
6 The motor is filled with oil, causing the elastomeric ring to expand and frictionally engage the inner
7 wall of the stator. This engagement prevents the bearing body from rotating and supports the shaft
8 in alignment.

9 As the motor heats up to operating temperature, the bearing body will expand slightly
10 outward. Also, the shaft will likely grow longitudinally, causing the bearing body to move
11 longitudinally with respect to the stator. Therefore, the bearing body must be precisely dimensioned
12 so that it does not engage the stator wall so tightly as to create excessive thrust loads on thrust
13 washers located above and below the bearing assembly. Also, the elastomer material used to
14 construct the bearing member must be carefully designed so that the swelling due to oil in the motor
15 is the correct amount.

16 17 SUMMARY OF THE INVENTION

18 The present invention involves a coiled member placed in a cavity formed in the outside
19 diameter of the bearing body. The purpose is to maintain contact between the bearing body and the
20 stator inner wall, which prevents rotation of the bearing body and stabilizes the shaft. In the
21 preferred embodiment, the coiled member is metallic. This broadens the operating uses of the
22 bearing member since the bearing member will not be restricted by variability and temperature

1 limitations of other materials, nor by the swelling limitations due to submergence in oil. The coiled
2 member may be comprised of a continuous coiled member, connected end-to-end to form a single
3 ring. Alternatively, the coiled member may be comprised of more than one coiled member segment.
4 These multiple coiled member segments can be connected end-to-end with straight wire sections
5 between them to form a single ring that sits in the cavity encircling the entire bearing body.

6 BRIEF DESCRIPTION OF THE DRAWINGS

7 FIG. 1 is a partial, vertical sectional view of an electrical motor having a bearing assembly
8 constructed in accordance with this invention.

9 FIG. 2 is an enlarged sectional view of the bearing member in the bearing cavity of FIG. 1.

10 FIG. 3 is a cross sectional view of the rotor and bearing member demonstrating the full
11 bearing member adapted to encircle the entire bearing body.

12 FIG. 4 is a cross sectional view of the rotor and bearing member demonstrating the partial
13 bearing member segments adapted to contact the bearing body only partially.

14 DESCRIPTION OF THE PREFERRED EMBODIMENT

15 Referring to FIG. 1, motor 11 includes a cylindrical housing 13. A stator 15 is rigidly
16 mounted within the housing 13. The stator 15 is made up of a large number of flat magnetic disks,

1 called laminations, having slots through which wires (not shown) are wound in a conventional
2 manner. All the disks of the stator 15 are of magnetic steel. The disks of the stator 15 may be
3 insulated from each other by coatings in a conventional manner. The stator 15 has a cylindrical inner
4 wall 17 that is of uniform constant diameter.

5 A rotor is rotatably mounted within the inner wall 17 of the stator 15. The rotor is comprised
6 of a shaft 19 and a large number of metallic disks or laminations. The laminations are divided into
7 identical rotor sections 21 approximately fifteen inches in length. A portion of two rotor sections
8 21 is shown in FIG. 1. Each rotor section 21 has an outer wall 23 that is closely spaced to the inner
9 wall 17 of the stator 15. Each rotor section 21 is secured by copper rods (not shown), with copper
10 end rings 25 on both sides. The ends of the copper rods are brazed or mechanically welded to the
11 end rings 25 to hold the laminations in each rotor section 21 together.

12 Each rotor section 21 is secured by a key (not shown) to the shaft 19 for rotation therewith.
13 The sections of the rotor 21 are not individually axially locked to the shaft 19. However, the
14 lowermost section of rotor 21 at the end of the shaft 19 is axially locked to support the sections of
15 the rotor 21 with respect to the shaft 19. Also, the uppermost section of the rotor 21 will be axially
16 locked to the shaft 19.

17 A bearing assembly is located between each of the rotor sections 21. The bearing assembly
18 includes a sleeve 27 that is secured to shaft 19 for rotation therewith by means of a key (not shown).
19 Sleeve 27 is preferably a bronze cylinder and is not axially locked to shaft 19. The upper edge or
20 circular rim of sleeve 27 contacts the lowermost lamination of the section of rotor 21 directly above,
21 and the lower edge of sleeve 27 contacts the uppermost lamination of the section of rotor 21 directly
22 below. Therefore, the sleeve 27 supports the weight of the rotor sections 21 above and transmits any
23 downward force on rotor sections 21 above to the next lower rotor section 21.

1 A bearing body 29 has a hub or inner portion 31 that is located within the inner bore of each
2 end ring 25, with a clearance between the end ring 25 inner diameter and the hub 31 outer diameter.
3 Hub 31 is cylindrical and has less length than sleeve 27. Hub 27 is preferably of steel, and may be
4 magnetic.

5 A thrust washer 33 is located around the outer diameter of sleeve 27 and between the section
6 of rotor 21 directly above and the upper edge of hub 31. A similar thrust washer 33 is located
7 between the lower edge of hub 31 and the rotor section 21 directly below. Thrust washers 33 are
8 preferably of a non-metallic material, such as glass reinforced phenolic material. The distance from
9 the lower side of the lower thrust washer 33 to the upperside of the upper thrust washer 33 is about
10 1/32 inch less than the height of sleeve 27. This prevents the thrust washers 33 from supporting the
11 weight of the rotor sections 21 located above.

12 Bearing body 29 has a flange or outer portion 35 that extends radially outward from hub 31.
13 Outer portion 35 has a cylindrical periphery 37 that is spaced inward from the inner wall 17 of stator
14 15 by a clearance of about 0.003 to 0.005 inch on the diameter. The longitudinal thickness or height
15 of the outer portion 35 is less than the distance between the two adjacent end rings 25. A plurality
16 of passages 39 extend through the outer portion 35 for communicating oil contained within the
17 housing 13. Bearing body 29 is normally of a metallic material, preferably nitralloy.

18 Referring to FIG. 2, the cylindrical periphery 37 of the bearing body 29 outer portion 35 has
19 an annular groove or cavity 41 extending circumferentially around bearing body 29 perpendicular
20 to the axis of shaft 19. Cavity 41 is preferably rectangular in cross-section. A coiled member 45
21 is recessed within the cavity 41. The space occupied by the coiled member 45 forms a toroid. The
22 coiled member 45 is metallic, preferably of spring steel. The coiled member 45 is sized to fit inside
23 of the cavity 41 and maintain contact with both bearing body 29 and the inside wall 17 of the stator

1 15, thus the coils of coiled member 45 have a diameter greater than the radial extent of cavity 41.
2 The coil member 45 may have a circular cross-section (as shown) or perhaps a square, rectangular,
3 triangular, or other suitable cross-section. A centerline 47 extends through the coils of coiled
4 member 45. The centerline 47 is a circumferential line with a radius relative to the axis of shaft 19.
5 The radius of the centerline 47 is less than the radius of the cylindrical periphery 37 of the outer
6 portion 35 of the bearing 29. In the undeflected condition, the coiled member 45 has a diameter that
7 is greater than the radial depth of the cavity 41 so that an outer portion protrudes past the cylindrical
8 periphery 37 of the bearing body 29. The diameter of the coiled member 45 is selected so that an
9 outer portion of the coiled member 29 will contact inner wall 17 of stator 15 and deflect. The
10 stiffness of the coiled member 45 is selected so that coiled member 45 will grip inner wall 17 of
11 stator 15 with sufficient force to prevent bearing 29 from spinning with the shaft 19.

12 Referring to FIG. 3, the coiled member 45 may be a continuous spring element, stretched
13 around the circumference of the bearing cavity 41 with its ends connected together (as shown).
14 Alternatively, in FIG. 4, the coiled member 45' may be non-continuous about the circumference of
15 the bearing cavity 41. A plurality of coiled member segments 45' may be spaced apart from each
16 other around the circumference of cavity 41. One embodiment employs three coil element segments
17 45' spaced equally apart (as shown) to provide three points of support at 120 degrees spacing around
18 the inside diameter 37 of stator 15. Coiled member segments 45' can be connected end-to-end with
19 straight wire sections between them to form a single ring.

20 During assembly, coiled member 45 is inserted into the bearing body cavity 41. The sleeve
21 27 and bearing body 29 are assembled upon the shaft 19 between rotor sections 21. Then the rotor
22 is inserted into the stator 15, with coiled member 45 radially deflecting as it slides past the
23 laminations of stator 15. Housing 13 is filled with oil, which does not cause swelling of coiled

1 member 45. The coiled member 45 continues to be engaged in contact with the bearing body cavity
2 41 and stator inner wall 17. In operation, sleeve 27 will rotate with the hub 31. The frictional
3 engagement due to deflection of coiled member 45 prevents bearing body 29 from spinning with
4 shaft 19. Heat will cause the rotor sections 21 to expand longitudinally, while stator 15 is prevented
5 from the same axial expansion. The resilient nature of the coiled member 45 allows some axial
6 movement of rotor sections 21 relative to stator 15 to accommodate this expansion.

7 The invention has significant advantages. The coiled member arrangement allows easy
8 insertion of the rotor into the stator 15 yet stops the bearing body 29 from spinning once the motor
9 begins operation. The metallic coiled member 45 has advantages over elastomeric T-rings used in
10 other systems in that it is not limited by the temperature limitations and variability of the elastomer.
11 The coiled member 45 centers the bearing body 29 within the stator 15 bore and provides good radial
12 support.

13 While this invention has been shown in only two of its forms, it should be apparent to those
14 skilled in the art that it is not so limited but is susceptible to various changes without departing from
15 the scope of the invention.